Case No.: North-501A

96 HOUR DURATION INSULATED CRYO-PACK FOR MAINTANING -40 DEGREE FAHRENHEIT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not Applicable

STATEMENT RE: FEDERALLY SPONSORED RESEARCH/DEVELOPMENT

[0002] Not Applicable

BACKGROUND OF THE INVENTION

[0003] The present invention relates in general to an insulated cryo-pack for maintaining and protecting material contained therein, and more particularly, to an insulated cryo-pack capable of maintaining -40oF for 96 hours even when the ambient temperature is elevated higher than 40oF.

[0004] Various types of containers have been developed for sustaining and protecting materials packed therein for a certain period of time during air and/or surface shipment. For example, in US Patent No. 4,682,708, an insulated shipping container capable of holding temperature as low as -30oF for less than 20 hours has been disclosed. In US Patent No. 5,441,170, an insulated shipping container adapted for transporting multiple temperature sensitive objects in one overall container over a period of time is disclosed. In US Patent No.5,615,796, a hazardous material container able to maintain a freezing conditions for 24 hours is disclosed. In US Patent No. 5,897,017, an insulated shipping container is disclosed. In US Patent No. 6,089,038, a transport container with layers of flexible insulating material is disclosed. The transport container is packed with product and slices of dry ice dissipating within 44 hours. In US Patent No. 6,543,491, a package for temperature-controlled packaging is disclosed. In US Patent Application Publication No. US2001/0030194 A1, a collapsible transport container that includes a collapsible rigid liner, an elastic insulation means and a rigid insulating plug is disclosed. In US Patent No. 5,102,004, a method and an apparatus for packaging refrigerated goods is disclosed. In US Patent No. 4,928,847, an apparatus for

packaging refrigerated goods capable of maintain a temperature near a freezing point is disclosed. In US Patent No. 6,325,281, a thermally insulating shipping system is disclosed. In US Patent No. 5,899,088, a temperature control system maintaining a target temperature by heat transformation between two materials having the phase change temperatures higher and lower than the target temperature. In PCT Application WO 02/099345 A1, a sorption cooling device is disclosed.

[0005] Although a great variety of containers has been developed for maintaining and protecting material during shipment, currently, none of the containers is capable of maintaining the temperature of the material at sub-zero temperature (-40oF) for a minimum timeframe of 72 hours. In the event of inclement weather or mechanical breakdown during the shipment, delay is inevitable, and the container of the material may be exposed at an ambient temperature much higher than the maintaining temperature. There is thus a substantial need to develop an insulated cryo-pack capable of maintaining temperature at -40oF for at least 96 hours to avoid damage of material to be shipped even when the ambient temperature is elevated higher than 40oF.

BRIEF SUMMARY OF THE INVENTION

[0006] The present invention provides an insulated cryo-pack for sustaining and protecting a material, comprising an inner container, a plurality of dry ice pellets and an outer container. The material is disposed and sealed within the inner container. The dry ice pellets are disposed in the outer container with a thickness of at least 2 inches thick on all sides of the inner container. Preferably, the dry ice pellets is filled in a barrier bag disposed in the outer container. The barrier bag assumes the interior contour of the outer container. The barrier bag includes an open top extending over the height of the outer container. When the inner container is disposed in the outer container, the open top of the barrier bag is folded over the inner container and secured by a tape with a width of about 2 inches. Preferably, the tape is applied perpendicularly across the folded portion of the barrier bag; or alternatively, the open top of the barrier bag includes a zip lock. To avoid rupture of the cryo-pack caused by sublimation of the dry ice pellets, the barrier bag may be punched with a plurality of vent holes with a diameter of about ¼ inches, for example. The inner and outer containers are made of corrugated fiberboards each with a thickness of about .255 inches. Both the inner and outer containers are sealed by reinforced gummed paper tapes. The tape sealing the inner container may have an H-pattern on top and

bottom surfaces thereof. The tape securing the outer container has an H pattern and a T pattern on top and bottom surfaces thereof, respectively.

[0007] In one embodiment of the present invention, the cryo-pack further comprises a plurality of foam panels disposed in the outer container and surrounding the inner container. Each of the foam panels has a thickness of about 2 inches. The seams between the adjacent foam panels are sealed by tapes. The cryo-pack further comprises at least one spacer disposed around the inner container within the foam panels, such that a cavity is formed between the inner container and the foam panels. The spacer has a thickness of about 2 inches.

[0008] In another embodiment of the present invention, an insulated cryo-pack for sustaining and protecting a plurality of materials comprises a plurality of internal containers, an inner container, a layer of dry ice pellets, and an outer container. The internal containers are used for individually packing the materials therein and disposed in the inner container. The layer of dry ice pellets is disposed surrounding the inner container with a thickness of about 2 inches. The internal, inner and outer containers are made of corrugated fiberboards each with a thickness of about .255 inches. For immobilizing the internal containers in the inner container, an extruded polystyrene cushion is disposed under the internal containers in the inner container. Preferably, a plurality of item reference tags are attached to the internal containers for indicating information of the materials contained therein, and a plurality of lids is disposed on the internal containers. Alternatively, a plurality of holding pads is disposed under the internal containers in the inner containers. Each of the holding pads comprises a recessed portion conformal to a periphery of a bottom surface of the internal container held thereby, and a plurality of upper holding pads disposed on the internal containers in the inner containers. The dry ice pellets is filled in a barrier bag disposed within the outer container for wrapping the inner container therein.

[0009] The present invention further provides an insulated cryo-pack comprising an inner container, an outer container, a plurality of foam panels, and at least one spacer. The inner container containing at least one material to be shipped therein is disposed in the outer container. The foam panels are disposed adjacent to an interior surface of the outer containers, and the spacer is disposed around the inner container to immobilize the inner container, so as to form a cavity between the inner and outer containers. A plurality of dry ice pellets may be disposed between the inner and the outer containers. Preferably, the dry ice pellets are filled within a

barrier bag. The inner and outer containers are made of corrugated fiberboard. The spacer and the foam panels each has a thickness of about 2 inches.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] These as well as other features of the present invention will become more apparent upon reference to the drawings wherein:

[0011] Figure 1 shows an exploded view of a cryo-pack provided by the present invention;

[0012] Figure 2 shows the process for securing the cryo-pack as illustrated in Figure 1;

[0013] Figures 3A and 3B are exploded view of a cryo-pack containing multiple materials to be shipped;

[0014] Figures 4A and 4B are exploded view of a cryo-pack in which multiple materials are contained;

[0015] Figure 5 shows a cryo-pack in which a cavity is formed between inner and outer container;

[0016] Figure 5A is a sectional view of a corner of the cryo-pack illustrating how adjacent foam panels are sealed with tapes.

[0017] Figure 6 shows an exterior feature of one cryo-pack provided by the present invention;

[0018] Figure 7 shows an exterior feature of another cryo-pack provided by the present invention;

[0019] Figure 8 shows the performance test results of the cryo-packs with and without a barrier bag at ambient temperature; and

[0020] Figure 9 shows the performance test results of the cryo-packs with various configurations while in an environmental test chamber.

DETAILED DESCRIPTION OF THE INVENTION

[0021] The present invention provides an insulated cryo-pack that uses dry ice, that is, solid carbon dioxide, as a refrigerant for maintaining and controlling temperatures of perishable frozen type materials. Such cryo-pack is designed to maintain the perishable type materials during a transit at an ambient temperature higher than 40oF for at least 72 hours. Preferably, the

container provided by the present invention is of corrugated fiberboard construction in accordance with the requirements of GFD DAA7319H002 or as specified in the applicable hazardous packaging instruction (HPI). The commercial application suitable for the cryo-pack includes: keeping various products such as meats, fish and medical specimens frozen; maintaining items such as chemicals, pharmaceuticals and foods at a specified critical temperature, including sub-zero, frozen and room temperature; preventing product such as chemicals, plants, medical supplies and fish from freezing; and minimizing extreme temperature variation for sensitive instruments, electronics, live fish, plant and flowers.

[0022] Figure 1 shows an exploded view of a cryo-pack of insulated corrugated fiberboard container. It is appreciated that the container as illustrated is only for descriptive and informative purpose. Other configuration may also be applied to achieve the same objectives. The cryo-pack comprises an outer shipping container 10, a barrier bag 12, at least one inner shipping container 14, and a top lid 16. As shown in Figure 1, the barrier bag 12 has an open top and is placed into the outer container 10. Preferably, the barrier bag 12 assumes the interior contour of the outer container 10 with the open top extends over the height of the outer container 10. The inner shipping container 14 is then placed in the barrier bag 12, and the portions of the barrier bag 12 extending over the height of the outer container 10 is folded over the inner shipping container 14, and the seam of the barrier bag 12 is tucked as shown in Figure 2. Clear poly tape 22 may be applied perpendicularly across the seam of the barrier bag 12 to secure the inner shipping container 14 therein. In this embodiment, two pieces of the poly tape 22 are used, and the width of the poly tape is about 2 inches. Alternatively, the seam of the barrier bag 12 can also be closed by a zip lock formed thereon.

[0023] The inner shipping container 14 is fabricated from a corrugated material with a presently preferred dimension of 9 inches × 9 inches × 12 inches. To optimize the protection, the inner shipping container 14 may be made of 350# double-wall corrugated material which meets with the ASTM-D-5118 standard. However, other materials such as 200# single-wall can also be used for cost reduction. When the perishable type material is disposed in the inner shipping container 14, the inner shipping container 14 is sealed using a tape (30 as shown in Figure 3B). Preferably, "H" patterned and filament reinforced PPP-T-60 tapes with a width of 2 inches are applied seal to top and bottom surfaces of the inner shipping container 14.

[0024] The barrier bag 12 may be filled with dry ice pellets with a thickness of at least 2 inches, such that when the inner container 14 is disposed in the barrier bag 12, each side of the inner container 14 is covered with a layer of dry ice pellets with a thickness no thinner than 2 about inches. To avoid rupture of the cryo-pack caused by sublimation pressure of the dry ice pellets, three vent holes 24 may be punched in a top surface of the barrier bag 12. In this embodiment, vent holes 24 are punched through the barrier bag 12 with a diameter of about ¼ inches. When the inner shipping container 14 is wrapped within the barrier bag 12 and disposed in the outer container 14, the lid 16 is placed on top of the folded barrier bag 12, and the top panels 20 of the outer container 10 are folded over the lid 16 and secured by a tape. Preferably, similarly to the tape 30, the tape for sealing a bottom surface of the outer container 10 includes an "H" patterned and filament reinforced PPP-T-60 tape with a width of 2 inches, while the tape for securing a top surface of the outer container 10 includes a "T" patterned and filament reinforced PPP-T-60 tape with a width of 2 inches. The "T" patterned tape applied on the top surface of the outer container 10 results in an unsealed edge allowing the pressure built up by the sublimation of dry ice to be released therefrom, such that rupture of the cryo-pack caused by the build-up pressure is further prevented.

[0025] In the present invention, the required amount of dry ice depends on the sizes of the inner and outer shipping containers. For example, for a cubic inner container with an inner dimension of 9×9×9 inch3 and an outer dimension of 9.31×9.31×9.31 inch3 (which is equal to 0.47ft3), to allow a layer of dry ice pellets with a thickness of about 2 inches surrounding the inner container, the inner dimension of the outer container is 13.3×13.31×13.31inch3 (which is equal to 1.36ft3). Therefore, the required volume of the dry ice pellets is 1.36ft3-0.47ft3=0.89ft3. The weight of dry ice pellets per cubic foot is 60lbs; and therefore, the required quantity of the dry ice pellets is 0.89ft3×60lbs/ft3=53.40lbs. For a thickness of about 2 inches, the outer dimension of the outer container is about (13.31+4.12)×(13.31+4.12)×(13.31+4.12) inch3, and the volume of the outer container is 17.43×17.43×17.43 cubic inches.

[0026] Figures 3A and 3B show an embodiment of a cryo-pack containing two materials therein. As shown in Figure 3A, two materials are individually packed in two internal containers 32 constructed using corrugated fiberboard in accordance with ASTM-D-5118 or the applicable hazardous packaging instruction (HPI). An item reference tag 33 is attached to each container 32 for indicating the information of the materials contained therein. Before disposing the internal

containers 32 in an inner shipping container 35, a cellulosic cushion (kimpac) 34 is used for holding the internal containers 32. Two top lids 36 are then placed on top of the internal containers 32 disposed in the inner shipping container 35. The top lids 36 may also contain content or item information of the materials covered thereby. The inner shipping container 35 is then sealed by a tape 30, preferably an "H" patterned and filament reinforced PPP-T-60 tape with a width of 2 inches. The sealed inner shipping container 30 is then wrapped by a barrier bag 36 in an outer shipping container 37 as shown in Figure 3B. Similarly, the barrier bag 36 may be filled with a layer of dry ice pellets with a thickness of about 2 inches.

[0027] Figures 4A and 4B show another embodiment of a cryo-pack containing multiple materials therein similar to the embodiment as shown in Figures 3A through 3B. In this embodiment, instead of using a kimpac, a pair of pads 44 is used to hold the internal containers 32. Each of the pads 44 has a perforation or recess 45 conformal to a profile of the bottom surface of the internal container 32 held thereby. Therefore, the internal containers 32, while being disposed and sealed in the inner shipping container 30, are immobilized during shipment. In addition to the holding pads 44, a pair of overhead pads 47 is further placed on top of the lids 36 for holding the internal containers 32 in place.

[0028] Figure 5 shows another embodiment of the cryo-pack provided by the present invention. In Figure 5, the barrier bag filled with dry ice pellets is not shown for clarity. It is anticipated that the barrier bag is used in this embodiment in the manner as disclosed in the previous embodiments. The material to be shipped is sealed in an inner container 50. Between the outer container 52 and the inner container 50, a plurality of insulating materials such as foam panels 53, 54 and 55 are disposed. In accordance with the geometry of the inner container 50, a bottom foam panel 53, four side foam panels 54 and a top foam panel 55 are used. Around the top, bottom and two elongate side walls of inner container 50, least one rectangular frame-like spacer 57 is used for holding the inner container 50, such that a cavity is formed between the foam panels 53, 54 and 55 and the inner container 50 for improve insulation effect. Preferably, the thickness of the spacer 57 is about 2 inches, and tapes 58 are applied to the seams between the foam panels 53, 54 and 55 as shown in Figure 5A to avoid heat loss therethrough.

[0029] Figures 6 and 7 show the exterior feature of the cryo-packs provided by the present invention. As shown in Figures 6 and 7, the top panel of the outer containers 60 is partially sealed by a "T" shaped tape 62. That is, the tape 62 is applied to the elongate seam across the

top panel and only one top edge of the top panel, such that the seam at the opposing top edge allows the sublimation of dry ice being released therethrough. Labels are applied to various places of the outer container 60. For example, on the side panel of the outer container 60, labels for indicating the content of refrigerant, content of material to be shipped, and form of material to be shipped are applied. On the top panel of the outer container 60, a label of handling instruction 66 is applied.

[0030] In Figure 8, a performance test of the cryo-pack with and without the barrier bag. To perform the test, a temperature sensor is applied on the exterior surface of the cryo-pack. For example, the temperature sensor can be secured to the exterior surface of the cryo-pack by a 2-inch wide clear tape. Another temperature sensor is disposed within the inner container with a probe protruding from one corner thereof, and the proximal corner of the outer container. Thereby, the ambient temperature and the product temperature can be read. The curve 80 represents the ambient temperature, the curve 82 represents the product temperature of the cryo-pack without the barrier bag, and the curve 84 represents the product temperature of the cryo-pack with the barrier bag. For both the curves 82 and 84, the cryo-pack includes RSC-ASTM-D-5118, double-wall inner and outer shipping containers, a 2-inch thick, 25PSI Dow square-edge extruded foam in between, and 51.60lbs of dry ice. The dimensions of the outer and inner shipping containers are 18×18×18 inch3 and 9×9×9 inch3, respectively. As shown, by exposing the cryo-pack without the barrier bag at an ambient temperature of about 60oF, the produce temperature 82 descends from about 10oF to about -105oF in about 36 hours, and up to 96 hours, the curve 82 rises to about -45oF. For the cryo-pack with the barrier bag, under the same ambient temperature condition 80, the product temperature decreases to -110oF within 30 hours, and the product temperature remains under -40oF for about 120 hours.

[0031] Figure 9 shows the temperature variation of cryo-packs disposed in a high-temperature environmental heat chamber. As shown, the chamber temperature (curve 90) fluctuates between 80oF and 130oF. The curve 92 represents the product temperature of a generic container, which refers to a corrugated RSC measuring approximately 14"×14"×20" that has been lined with 1.0 lb/ft3 density, 1" expanded polystyrene foam (four side pieces and one piece on each of the top and bottom). This type of container is sometimes reused for short duration shipments of frozen materials after it is received with various frozen commodities from the suppliers. The curve 94 represents the product temperature of a cryo-pack with Dow square-

edge foam and the barrier bag. The curves 96 and 98 represent the product temperature of cryo-packs with the configurations met with normal and modified HPI-019, which is a container configuration developed to support shipments of hazardous materials as defined by the Department of Transportation. The quantity of dry ice contained in each cryo-pack is about 49.5lbs. Table I shows the temperature for each cryo-pack at different elapsed time.

Cryo-pack / Time Elasped	Dow square-edge (°F)	HPI-019 Normal (°F)	HPI-019 Modified (°F)	generic container (°F)
0 Hours	8.1	-4.5	16.1	-81.5
6 Hours	-32.8			
18 Hours	-78.8			
21 Hours	-84.0			
24 Hours	-88.4	-94.6/-93.6	-69.2/-63.2	-120.2
48 Hours	-89.3	-103.4/-103.6	-96.1/-93.4	-113.1
72 Hours	-52.3	-99.7/-101.2	-100.1/-99.6	-64.2
96 Hours	0.7	-62.2/-65.2	-70.0/-72.4	+33.2
108 Hours		-40		
110 Hours	+31.2			
112 Hours			-40	
123 Hours		0		
136 Hours			0	

Table I

[0032] According to the performance test, the cryo-pack provided by the present invention maintains the product temperature lower than -40oF for at least 72 hours even when the ambient temperature fluctuates between about 80oF to about 130o. By disposing the cryo-pack in an

environmental temperature at about 60oF, the product temperature is maintained no higher than -40oF for at least 96 hours.

[0033] Therefore, when inclement weather or mechanical breakdown occurs to cause delay of shipment, the product contained in the cryo-pack provided by the present invention is adequately maintained and protected for at least 72 hours.

[0034] This disclosure provides exemplary embodiments of the present invention. However, the scope of the present invention is not limited by these exemplary embodiments. Numerous variations, whether explicitly provided for by the specification or implied by the specification, such as variations in structure, dimension, type of material and manufacturing process may be implemented by one of skill in the art in view of this disclosure.